CLAIMS

1. An electron emitting device having a lower electrode on a side near to a substrate and an upper electrode on a side remote from the substrate respectively, formed of a plurality of electron emitting elements emitting electrons from a side of the upper electrode, wherein space is formed between the electron emitting elements, and the upper electrode extends across the plurality of electron emitting elements and the space by a bridging portion of the upper electrode.

2. The electron emitting device according to claim 1, wherein the bridge portion is provided with at least one through hole or notched portion.

3. The electron emitting device according to claim 2, wherein the through hole or notched portion is circular-shaped, rectangular-shaped, diamond-shaped, barrel-shaped, star-shaped, shoulder drum shaped, or a shape formed of part of these shapes.

4. The electron emitting device according to any of claims 1 to 3, wherein the bridge portion extends approximately parallel to the substrate.

5. The electron emitting device according to any of claims 1 to 4, wherein the lower electrodes and the upper electrodes connected at the bridge portions are stripe shaped electrodes arranged in positions that are mutually orthogonal.

6. The electron emitting device according to any of claims 1 to 4, wherein the upper electrode extends over a plurality of electron emitting elements and spaces by the bridge portions

without the electron emitting elements being limited to the row or column directions, and the lower electrode is separated and independent for each electron emitting element.

7. The electron emitting device according to claim 5 or claim 6, wherein the electron emitting elements further comprise an insulator layer and an electron supply layer made from a semiconductor deposited between the lower electrode and the upper electrode, and when a voltage is applied between the lower electrode and the upper electrode electrons are emitted from the upper electrode.

8. The electron emitting device according to claim 7, wherein the bridge portion comprises the material of the insulator layer that is integral with the insulator layer of the electron emitting element.

9. The electron emitting device according to any of claims 1 to 8, wherein the electron supply layer is made from an amorphous phase that comprises silicon or a mixture or compound whose main component is silicon.

10. The electron emitting device according to any of claims 1 to 9, further comprising at least one electron emitting section formed from an island area in which the film thickness of the insulator layer and the upper electrode gradually decrease towards the electron supply layer.

11. The electron emitting device according to claim 10, wherein in the island areas the upper electrode terminates on the insulator layer.

12. The electron emitting device according to claim 10 or claim

11, wherein in the island areas the insulator layer terminates on the electron supply layer.

13. The electron emitting device according to any of claims 10 to 12, wherein the island areas are depressions in the flat surface of the upper electrode.

14. The electron emitting device according to any of claims 10 to 13, wherein the insulator layer is made from dielectric material, and a part other than the island areas has a film thickness of 50 nm or greater.

15. The electron emitting device according to any of claims 10 to 14, wherein electrically insulating masks are provided in the island areas.

16. The electron emitting device according to any of claims 10 to 15, wherein a carbon area comprising carbon, or a mixture with carbon as a component, or a carbon compound is provided in the top, bottom, or middle of the island areas.

17. A method of manufacturing an electron emitting device having a lower electrode on a side near to a substrate and an upper electrode on a side remote from the substrate respectively, formed of a plurality of electron emitting elements emitting electrons from a side of the upper electrode, with space being formed between the electron emitting elements, and the upper electrode being extending across the plurality of electron emitting elements and the space by a bridging portion of the upper electrode, the method comprising:

an electron emitting section forming step of forming a laminated body on which an upper electrode material layer is deposited to

form a plurality of electron emitting elements on a substrate;
a bridge forming step of forming a plurality of bridge portions provided with at least one through hole or notch along a line that separates the plurality of electron emitting elements by etching the upper electrode material layer;
a cutting step of etching part of the exposed insulator layer to or near to the substrate and lower electrode by anisotropic etching using the bridge portions as a mask; and
a separating step of separating the exposed part of the insulator layer into the plurality of electron emitting elements by isotropic etching to enlarge the space using the bridge portions as a mask.

18. The method of manufacturing an electron emitting element according to claim 17, wherein in the cutting step mixed gas comprising CH_2F_2, SF_6, Cl_2 is brought into contact with the exposed part of the insulator layer.

19. The method of manufacturing an electron emitting element according to claim 17 or 18, wherein in the separating step mixed gas comprising CF_4 is brought into contact with the exposed part of the insulator layer.

20. The method of manufacturing an electron emitting element according to any of claims 17 to 19, wherein the electron emitting section forming step comprises:
an electron supply layer forming step of forming an electron supply layer consisting of silicon or a mixture whose main component is silicon or a silicon compound on the substrate;
a mask forming step of forming a mask on the electron supply layer that forms a canopy around the portion in contact with the electron

supply layer;

an insulator layer forming step of forming an insulator layer formed from a thin film of insulation material by depositing insulation material on the electron supply layer and the mask, so that around the part in contact with the mask the film thickness of the insulator layer gradually decreases to form at least one island area; and

an upper electrode forming step of forming a film of the upper electrode on the insulator layer to form the island area as an electron emitting section.

21. The method of manufacturing according to claim 20, further comprising a carbon area forming step of forming a carbon area comprising carbon or a mixture with carbon as a component or a carbon compound in the top, bottom, or middle of the island areas.

22. The electron emitting device according to claim 20 or claim 21, wherein in the bridge forming step the upper electrode and the insulator layer are etched by the isotropic etching method to form bridge portions including the material part of the insulator layer integral with the insulator layers and upper electrodes of adjacent electron emitting elements, and a canopy-shaped structure made from the material of the insulator layer is formed in the through holes projecting towards the center of the through holes.

23. The method of manufacturing according to any of claims 20 to 22, wherein the masks are micro masks comprising a support portion that projects in a direction normal to the substrate and a main mask that projects in a direction parallel to the substrate

from the support portion, and the mask forming step comprises the steps of:

forming a support portion material layer and a main mask material layer on the substrate;

forming a resist mask thereon by photolithography so that at least part of the electron supply layer is exposed; and

etching the main mask and the support portion in that order by the dry etching method and the wet etching method to form the micro masks.

24. An imaging element, comprising:

an electron emitting device according to any of claims 1 to 16;

a photoelectric conversion film approximately parallel to and in opposition to the upper electrode and enclosing a vacuum space;

an optically transparent electrically conducting film deposited on the photoelectric conversion film; and

an optically transparent front substrate that supports the photoelectric conversion film and the optically transparent electrically conducting film.

25. The imaging element according to claim 24, further comprising a mesh electrode arranged within the vacuum so as not to contact the electron emitting device or the photoelectric conversion film.

26. A display device comprising:

an electron emitting device according to any of claims 1 to 16; and

an optically transparent front substrate in opposition to the upper electrode and enclosing a vacuum space, with a fluorescent

layer arranged on the surface on the side of the vacuum space, and a collector electrode formed on the fluorescent layer and in opposition to the upper electrode.

27. The display device according to claim 26, having an image display array comprising a plurality of light emitters corresponding to the fluorescent layer.

28. The display device according to claim 26 or claim 27, wherein the image display array comprising a plurality of light emitters corresponding to the fluorescent layer is delimited by a dark-colored or black colored matrix layer or striped layer.